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ABSTRACT

This study is an annotated bibliography of literature dealing with the effects of teaching mathematics by mastery learning. It is subdivided into four areas: History and Development of Mastery Learning; Mastery Learning, an Alternative to Traditional Instruction; Implementation of Mastery Learning; and Studies of Mastery Learning in Mathematics. In addition to conclusions the document includes five recommendations: (1) raise teacher expectations by exposing educators, through extensive in-service, conferences or workshops to the philosophies of Carroll (1963) and Bloom (1976)--namely that all students can learn and most can achieve mastery; (2) as a result of increased awareness and education, school districts or corporations should work to design programs, set educational standards and develop a model of operational details; (3) districts or corporations should provide release time or in-service for departmental program implementation--writing learning objectives and parallel corrective and enrichment activities as well as designing formative and summative tests; (4) outcome based national networks should develop and operate computer resource banks for sharing corrective and enrichment activities, tied to specific learning objectives; (5) publishers should produce curriculum materials suitable to mastery learning, with formative and summative tests as well as corrective and enrichment activities linked to specific learning objectives. (PK)

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TEACHING MATHEMATICS: MASTERY LEARNING VERSUS TRADITIONAL INSTRUCTION

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for the course S591--Exit Project
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INTRODUCTION

In 1963 Carroll, a Harvard educational psychologist, designed a model to explain why students succeed and fail. Carroll's Model for School Learning was revolutionary in that it transformed the labels of "smart" and "dumb" to "fast" and "slow" learners. Carroll (1963) defined aptitude as the amount of time needed to learn a task under optimal conditions. The degree of learning then became a function of the time a student actually spent on learning relative to the time that was needed (Guskey (1985).

Bloom latched onto Carroll's model and developed a teaching strategy to incorporate the notion that students differ in terms of time required to learn. The basic premise that all students can learn, according to Bloom (1976) had been central to tutoring for thousands of years. It was, however, a radical proposal for classroom group-instruction of the seventies. Guskey (1985) reported on the key elements of the mastery sequence: clearly defined objectives; formative tests; feedback/correctives; enrichment activities; summative tests and program evaluation. The main difference between mastery and traditional settings were in mastery's formative/feedback/corrective/enrichment loop. Corrective activities provided the slower student with more time to learn.

Mastery learning denied the inevitability of the normal curve, in student achievement (Alexander 1981). "The bell curve," stated Bloom (1968), "with its expectant 30 percent

failure had been the most wasteful and destructive aspect of our eudcational system." The bell curve has been used so long that educators teach to the predictability of its outcome.

For the past twenty years, field research data of mastery learning, in all grade levels and subjects, though predominantly in reading and mathematics, have been reported. Various socio-economic areas, entire districts, state rural schools (Utah) and foreign nations have all joined in on collecting and analyzing experimental data. Predominantly accounts of academic improvement have been the rule though concerns over time management and insufficient teacher training have also erupted (Arlin 1982, 1984...Hart 1985).

STATEMENT OF THE PROBLEM

Mastery levels of performance in mathematics are attained by a minority of students with traditional instruction. This peculiar phenomenon of our educational system has not only been accepted, but also expected. Further, the notion of inherent aptitude has crippled the potential of many a mind. Public education, according to Hart (1985) ranks, screens, labels (for scape-goating) and then produces one-third failure.

PURPOSE OF THE STUDY

Based upon the impressive claims of student achievement, educators in mathematics should investigate the feasibility of incorporating the techniques of mastery learning within their classroom instruction. Information is needed to enable teachers of mathematics to become aware of the theory of mastery learning as well as the techniques of implementation. Teachers should have enough knowledge at their disposal to weigh the advantages and disadvantages based upon results of execution in various settings.

ORGANIZATION OF THE STUDY

This study is an annotated bibliography of literature dealing with the effects of teaching mathematics by mastery learning. It is subdivided into four areas. They are 1) History and Development of Mastery Learning, 2) Mastery Learning, an Alternative to Traditional Instruction, 3) Implementation of Mastery Learning and 4) Studies of Mastery Learning in Mathematics. There is some overlapping of areas since they are interrelated and many authors deal with more than one aspect of mastery learning.

LIMITATIONS OF THE STUDY

This study is limited as mastery learning is a somewhat recent phenomena, not being field tested until the seventies. Though results overwhelmingly indicate that mastery learning has a positive influence on achievement, more research is necessary. The effectiveness of mastery learning is difficult to assess, because as in any educational endeavor, the product is a function of numerous interrelated variables (Carroll 1970). The results of some field studies may also be suspect because of their brevity or insufficient teacher training (Fitzpatrick 1985, Taylor 1983).

GLOSSARY

The following terms have been used extensively in this study and are defined as dictated by their use in mastery learning literature.

aptitude - The amount of time needed to learn a task under optimal conditions. (Carroll 1963)

Competency Based Education (CBE) - An approach to instruction that assumes each learner will reach specific minimum levels of achievement or competency. (Dejnozka 1982) Mastery learning practices are central to CBE. (Chandler 1982)

Correctives/Feedback - An individual aspect of mastery learning. Feedback from formative tests provide information of the students' learning progress. The information is paired with specific activities for remedying the learning difficulty. Corrective activities teach the same material in a different way from the original instruction.

Criterion-Referenced Tests - A test in which each item is related or referenced to a specific pre-established learning objective. Formative and summative mastery learning tests are criterion referenced.

Diagnostic Prescriptive Teaching (DPT) - A teaching strategy which includes testing (diagnosing) students' areas of weaknesses and then assigning (prescribing) activities intended to correct the weaknesses identified.

Enrichment Activities - An individual aspect of mastery learning which provides opportunities to expand and enrich the learning of students who scored at mastery or higher on a formative test.

Formative tests - Assessment during the developmental or formative stages of a program. In mastery learning formative tests are used for immediate feedback in checking student progress -- not to assign grades. Results indicate corrective or enrichment activities.

Learning Objectives - Description of specific expectations which describe the skills and abilities students are to acquire as a result of the teaching process.

Mastery learning - An instructional strategy outlined by Bloom (1968), based on the premise that almost all students can achieve mastery if given enough time. It is group-based and teacher-paced and includes the elements of specific objectives, formative tests, feedback/correctives, enrichment activities and summative tests.

Norm-Referenced Examinations - Standardized tests in which an individual's performance is compared or evaluated in relation to the performance of others. It is used for determining percentile ranks, stanines and grade equivalences. (Good 1973)

Norms - Averages of the performances of various groups of individuals who have previously taken a standardized test. (Wandt 1965)

Outcome Based Education (OBE) - A variety of instructional strategies in which specific learning or achievement outcomes, not predetermined time and schedule factors, govern the placement and movement through the curriculum. (Rubin/Spady 1984) Mastery learning is an OBE strategy.

Perseverance - The amount of time the learner is willing to engage actively in learning. (Carroll 1963)

Personalized Systems of Instruction (PSI) - An OBE instructional model developed by Keller (1968). PSI is an individually-based, student-paced extension of programmed instruction that includes a personal/social element. (Guskey 1985) Grades are based on the number of units completed successfully over a specified time.

Standard for Mastery - A teacher set level of performance on a test that indicates the material has been learned well. The standard for mastery in mastery learning is usually above 80 percent. Specific critical objectives may demand 95 percent or better.

Standardized Tests - Commercial tests with broad objectives to fit different courses and sociological groups. A student's performance is judged on how well he or she compares to others of the same age and grade. (Also called Norm-Referenced Tests.)

Summative Tests - The assessment of the overall effectiveness of a program. Used at the end of instruction to certify mastery and assign grades.

Traditional/convention Instruction - A teaching strategy of the sequence lecture/discussion/guided practice/unit testing. Tests are generally commercial, standardized and norm-referenced "on the curve" for grade assignment. Generally the class moves to the next learning unit with one-third mastery.

ANNOTATIONS

HISTORY AND DEVELOPMENT OF MASTERY LEARNING

Block, James H. "Mastery Learning: The Current State of the Craft." Educational Leadership. November, 1979, 37:114-117.

Block reported on the widespread use of mastery learning, from the single class, one subject experiment of the 1970's to the present entire district and large scale projects in numerous nations. Examples of research were cited evaluating the effects of various performance standards, isolating factors essential to the successful application of mastery learning and reviewing other research from a mastery learning perspective. As an example of the latter, Block reviewed the behaviors of the California Beginning Teacher Evaluation Study (BTES) and drew parallels with mastery learning. Studies were also cited that correlated the theoretical linkage of mastery learning and learning for competence. The main concepts of Cantlay and Block's model were outlined to suggest the future expansion of mastery learning into humanistic areas of education.

Block, James H. Mastery Learning Theory and Practice. New York: Holt, Rinehart and Winston, Inc., 1971.

Block assembled a book of articles which explain the theory and implementation of mastery learning as well as a relevant bibliography of research with annotations. Part one included papers by Airasian, Block, Bloom and Carroll. Part two summarized the research and classified each abstract according to the following categories: 1) Aptitudes and rate of learning, 2) Ability to understand instruction, 3) Quality of instruction, 4) Perseverance, 5) Time as a variable in attaining mastery, 6) Affective consequences of school learning, and 7) Use of mastery concepts and strategies. After summarizing the research and literature, Block concluded that American education is in a critical period in its history. Block further stated that mastery learning offers exciting possibilities of increased learning for the majority of students, instead of just a few. Study results indicated that mastery strategies enabled about three-fourths of students to learn to the same performance standards of the top fourth of students with conventional, group-based instruction.

Bloom, Benjamin S. Human Characteristics and School Learning. New York: McGraw-Hill Book Company, 1976.

The theme of this book was that variations in and levels of learning are alterable and in fact products of the students' "learning history" and "quality of instruction." Bloom isolated three independent variables of the learning process. They are: 1) Cognitive Entry Behaviors - Students history of previous development/level of attainment of prerequisites; 2) Affective Entry Characteristics - Extent to which students can be motivated to engage in learning; 3) Quality of Instruction - Based on research, Bloom estimates one-fourth of achievement can be effected by the way schools "manage" learning. According to Bloom, his mastery learning theory, influenced by Carroll's model, is based on an "old" idea that most students can learn successfully.

Bloom, Benjamin S. "Learning for Mastery." (UCLA-CSEIP) Evaluation Comment. 1968, 1:1-12.

Bloom stated that the bell curve, with its expectant 10 percent "A" and 10 percent failure, is the most wasteful and destructive aspect of our educational system. He further contended that educators agree on the issue of individual differences and in fact teach as though only a minority can learn successfully! Bloom's teaching strategy was developed to help more students reach their potential. Five major educational variables were identified in the learning process. They are 1) Aptitude for particular kinds of learning, 2) Quality of instruction, 3) Ability to understand the instruction, 4) Student perseverance and 5) Time "allowed" for learning. Bloom's research has verified that mastery learning can have a positive influence on attitude, self-confidence and achievement. Bloom proposed that 95 percent of all students can achieve mastery if given enough time and appropriate types of help.

Carroll, John B. "A Model of School Learning." Teachers College Record. 1963, 64:723-733.

Carroll designed a conceptual model of factors affecting success in school learning. The model included five elements which interact to encompass the degree of learning. Of the five elements, two are a product of outside situations: opportunity - time allowed for learning; and the quality of instruction. Factors within the individual are aptitude - the amount of time needed to learn the task under optimal conditions, ability to understand instruction and perseverance - the amount of time the learner is willing to engage actively in learning. The model is as follows: Degree of learning = f (time actually spent/time needed). Anything less than "all the time needed to master" was labeled as underachievement. Carroll warned that the concept of underachievement does not automatically imply the possibility of remediation. Numerous avenues for research have been opened by Carroll's model. Carroll's model was developed around the concept of learning tasks and has been used as a measure of the effectiveness of specific teaching situations.

Keller, Fred S. "Goody-Bye, Teacher..." Journal of Applied Behavior Analysis. Spring, 1968, 1:79-89.

Keller reported on his personal experience in the development of a "fresh" application of reinforcement teaching. In 1965, Keller developed a first-semester course in General Psychology at Arizona State University. The course has been an inexpensive and increasingly effective adventure in Mastery Learning. Consistently 65 to 70 percent of the students received A's and B's. Keller's groups far out-performed students from a similar class at an Ivy League school based on an unannounced mid-term prepared by the Ivy League instructor. Keller summarized the distinctive features of his procedure: 1) Individual pacing; 2) Unit-mastery before advancement; 3) Lectures and demonstrations for motivation; 4) Stress on written word; 5) Proctors for immediate feedback, retesting and tutoring.

MASTERY LEARNING, AN ALTERNATIVE TO TRADITIONAL INSTRUCTION

Brophy, Jere. "Synthesis of Research on Strategies for Motivating Students to Learn." Educational Leadership. October, 1987:40-48.

Brophy categorized and enumerated thirty-three strategies for motivating students to learn. No less than twenty-three references were listed to authenticate his "synthesis of Research." Strategies were explained in terms of their application in the classroom as well as displayed in an easy reference highlight box. All strategies were divided into the following categories: Essential Preconditions, Motivating by Maintaining Success Expectations, Motivating by Supplying Extrinsic Incentives, Motivating by Capitalizing on Students' Intrinsic Motivation, Stimulating Student Motivation to Learn. Mastery learning was cited as a method to procure items under "Motivating by Maintaining Success Expectations." Many of the ideas could be adapted to most any teaching method, including the traditional setting. Mastery Learning techniques particularly coincide well with the Expectancy X Value Theory, which Brophy stated, guided his development of motivational strategies. The Expectancy X Value Theory, formulated by Feather in 1982, states that effort is related to expected success and value or reward for participation.

Chandler, Theodore A. "Mastery Learning: Pros And Cons." NAASP Bulletin. May, 1982:9-15.

Chandler presents a case for mastery learning by comparing achievement scores of mastery and non-mastery groups. In two separate reviews of over 150 studies, two-thirds were in favor of mastery scores and only three total were in favor of non-mastery. Chandler listed 7 "pros" for mastery Learning (ML). They are as follows: 1) Encourage cooperation over competition; 2) Enhance self-worth and positive academic attitudes; 3) Minimize achievement differences; 4) Immediate feedback for students and teachers; 5) "F's" and "copping out" not allowed - material is mastered or "in progress;" 6) Forces schools to examine curriculum; 7) Teachers are motivated to improve teaching techniques. The reasons against mastery learning were not very convincing. Even Chandler who listed 9, expounds the value of Mastery Learning. The confusion in the "cons" were exemplified by reason #3, tests don't motivate and reason #9, which stated Mastery Learning robs students of failure experiences.

Clancy, Peter L. 19 Improving Schools and Why: Their "Formula for Success." Educational Resources Information Center, ED 228 713, 1982, 211 pp.

This study was conducted to identify the factors which contributed to a notable improvement in the achievement levels of 19 elementary schools in Michigan. Consistent outstanding gains over four years were observed in mathematics and reading test scores on the Michigan Educational Assessment Program (MEAP). A computer analysis and numerous interviews were conducted. There was no one resultant single key to success but seven elements were found to be common to all 19 schools. They are: 1) The superintendent was a leader and proponent of academic achievement; 2) The principals were strong leaders and adept in curriculum and instructional techniques; 3) The staffs were stable, flexible and innovative; 4) Each staff demonstrated a high degree of intercommunication; 5) Communication was good between the school and home which produced strong parental support; 6) Educational expectations were identified and known by all involved in the process; 7) The instructional programs incorporated mastery learning.

Evans, Richard M. "Military Curriculum Development." Educational Leadership. November, 1981: 121-124.

How do you train marginally literate 17-year-olds, 30 percent of whom are flunking technical courses, for military occupations, which are increasingly involved in higher levels of technology? The Marine Corps' response to this dilemma, according to Evans, was the Instructional Systems Development (ISD) process, along with an application strategy of mastery learning. Staff training came after the curriculum development committee worked through the phases of analysis, design, development, implementation and validation. The core of the program was Bloom's philosophy that all students CAN learn. Variances from Block's standard were allowing learning time to vary and using microcomputers for recordkeeping and prescriptive instruction. Students began attaining levels of mastery in 30 percent less time. By 1981 three courses were operating successfully and an effort was underway to convert the entire school.

Guskey, Thomas R. "The Effects of Change in Instructional Effectiveness on the Relationship of Teacher Expectations and Student Achievement." Journal of Educational Research. 1982, 75:345-348.

This study investigated how a change in teacher's instructional effectiveness would effect the relationship between teacher's original expectations and student outcomes. Mastery learning was used as the means of altering teacher instructional effectiveness. Forty-four intermediate and high school teachers attended a mastery learning workshop and then taught two classes in the same subject and grade, one in a mastery format and the other in whatever method the teacher chose. Teachers rated their students, from 1 to 5 in academic potential, three weeks after teaching and at the end of the semester. Correlation data tables showed that teachers in the positive change group remained constant in their ratings of control group students but were not consistent for ratings of students in their mastery classes. Guskey speculated as to whether this pattern was due to a difference in student-teacher interaction patterns or whether teachers actually viewed students differently in mastery learning.

Guskey, Thomas R. and Sally L. Gates. "Synthesis of Research on the Effects of Mastery Learning in Elementary and Secondary Classrooms." Educational Leadership. May, 1986:73-80.

Guskey and Gates summarized the results of 27 elementary and secondary mastery learning programs. The following positive outcomes were observed: 1) Achievement results were overwhelmingly positive, but varied some in each study. 2) Students from all levels benefited from master learning but somewhat more so in elementary and junior high than at the high school level. 3) Effects in language arts and social studies were slightly more than in science and math - probably because science and math are already taught in a sequential manner. 4) Students tend to retain what they have mastered longer with mastery learning, but more studies are needed on long-range consequences. 5) Over a series of time, students spend less time on correctives. Mastery classes engage students in learning time more than traditional classes. 6) Teachers who have used mastery learning develop more positive attitudes toward teaching, higher expectations of their students, and greater responsibility for learning outcomes.

Hyman, Joan S. and A. Alen Cohen. "Learning for Mastery: Ten Conclusions After 15 Years and 3,000 Schools." Educational Leadership. November, 1979:104-109.

Based on data gathered from implementing Learning for Mastery (LFM) curriculum in reading and math in over 3,000 schools, Hyman and Cohen deduced ten conclusions. The list includes: 1) LFM is considerably more effective than traditional curriculums. 2) LFM's effects, rather than known effectiveness, should be investigated. 3) Increasing P Ration (time on task), increases mastery. 4) LFM learners master more objectives during a given time period than students in non-LFM. 5) Seven techniques increase participation and mastery. (The seven steps are typical LFM: Teaching to clearly stated objectives; positive feedback, and so on.) 6) PSI or individualized LFM designs are more effective than group LFM. 7) Competency-based instruction implies but does not require LFM. 8) In any curriculum, the observed practice in the real world is the true objective. 9) In general, schools are more concerned with teaching than with learning. 10) Most teachers are easy to train as LFM classroom managers.

Nelson, Kerry D. Report on Utah's Rural Schools. Educational Resources Information Center, ED 261 839, October, 1985, 15 pp.

Utah's state legislature, state board of education and Far West Laboratory asked for and financially supported an educational reform of its rural schools. In 1984 large group workshops and conferences sprang up across the state. Spady, President of Far West Laboratory, and Santorno instigated the massive ultaist movement toward Outcome Based Education (OBE). Barber, a national consultant on mastery learning conducted the training for many of the conferences and workshops. Over 100 Utah educators became certified as Mastery Learning Trainers. According to Nelson, the most valuable and marked element of the revolution, was the statewide cooperative effort. Brief reports from seven counties showed evidence of significant to phenominal academic gains.

Okey, James R. "Consequences of Training Teachers to Use a Mastery Learning Strategy." Journal of Teacher Education. 1977, 5:57-62.

This study involved 20 classrooms, 44 teachers/interns, and four urban, Indianapolis, elementary and middle schools. The purpose was two-fold: 1) To provide positive teacher in-service training in the implementation of mastery learning and 2) to measure the effects of student attitudes and achievement with mastery learning. Teachers studied the five-step plan for mastery, prepared their own materials to accompany their regular curriculum and then taught a four-week unit in mathematics or language arts. The result of six different posttest, questionnaire and observation forms were studied. Conclusions were presented in rhetoric and table form. Okey found that after three weeks of training, teachers were able to implement mastery learning with positive attitudes and that mastery taught students exhibited more favorable attitudes and higher achievement than nonmastery.

Popham, James W. "Task-Teaching Versus Test-Teaching." Educational Measurement: Issues and Practice. Winter, 1983, 2:10-11.

Teaching to the test has new meaning and is now not only acceptable but an effective instructional strategy! What caused this change of philosophy is that measurement or assessment tests are now criterion-referenced with clear skill or objective goals. Teachers need to teach the test domain to give their students practice in identified minimum skills. In fact, on-target teaching is now mandatory. Popham substantiates this claim by citing the results of the Debra P. v. Turlington trial in Florida. The U.S. Fifth Circuit Court of Appeals ruled that it would be unconstitutional to deny diplomas to Florida students on the basis of a test whose contents had NOT been taught. In this case Judge Carr further ruled that Florida could deny a high school diploma to the student in question because sufficient preparation had been presented. Based on this ruling Popham suggests that high-stage test developers keep their skills specific so students can master the skills in a short period of time and teaching may then extend beyond the scope of the test.

Popham, James W., Keith Cruse, Stuart Rankin, Paul Sandifer, and Paul L. Williams. "Measurement-Driven Instruction: It's on the Road." Phi Delta Kappan. May, 1985, 66:628-634.

Instructional programs and student learning can be improved by measurement or competency testing, stated Popham, Cruse, Rankin, Sandifer and Williams. Their conclusions were based on research from the city of Detroit and state programs in Maryland, Texas and South Carolina. Though all programs were somewhat different, the following were common characteristics: 1) Each program was a result of public dissatisfaction with education. 2) Each measurement was criterion referenced. 3) Each program increased communication of the community, teachers, administration and curriculum committees regarding objectives and basic competencies. 4) Each clarified instructional targets and skills. 5) Outcomes were used to implement appropriate compensatory services. 6) Minority scores improved the most. 7) Student performances improved drastically!

Stevenson, Harold W. "America's Math Problems." Educational Leadership. October, 1987:4-10.

Stevenson, a Professor at the University of Michigan, conducted a study on Asian and American students' performance in mathematics. The research was supported by grants from various American Foundations. Data to support Stevenson's conclusions came from a report of the Second International Mathematics Study (McKnight 1987) as well as from previous and current studies by Stevenson. Tests were given to eighth grade students in 20 countries as well as representative studies of 3,000 first graders and 3,500 fifth graders. In addition there were classroom observations and parent interviews. The following conclusive points were made: American students are not doing as well in math as their peers in other countries; America's math problems begin early and get worse after formal instruction; America's students and parents are confident about their math skills and find math easy; Americans do not consider math as important as reading in elementary school; Less time is devoted to math and direct instruction in America. Proponents of mastery learning should note the followingg. In Asia, Stevenson reported, differences in innate ability was deemphasized, tracking was unknown and teachers and parents believed any child was capable of learning. In America, however, teachers emphasized innate differences and used them as a base for variation of achievement.

Trembath, Richard J., and Richard T. White. "Mastery Achievement of Intellectual Skills." Journal of Experimental Education. Spring, 1979, 47:247-252.

An experiment was conducted in Melbourne, Australia, with 148 eighth grade math students and a class of 129 high school junior physics students. They were pitted against each other to check mastery of calculating the velocity at a point on a curved position-time graph. This particular task was chosen because of its validated hierarchy by White. The eighth graders were divided into four groups with mastery/non-mastery and forward/reverse sequential learning as variables. The forward sequence mastery learning eighth graders out-performed everyone! The implication was that improved performances of learners will result if validated learning hierarchies are used to sequence learning. Trembath and White added a new factor to further improve Bloom's mastery learning strategy.

Waxman, Hersholt C., Margaret C. Wang, Kenneth A. Anderson, and Herbert J. Walberg. "Synthesis of Research on the Effects of Adaptive Education." Educational Leadership. September, 1985:26-29.

A group of researchers completed a statistical analysis of 38 studies involving 7,200 students in K-12, in mathematics, reading, language arts and science. They documented that adaptive programs benefited students' behavioral and affectived outcomes. Adaptive programs used a variety of curriculums and teaching strategies, including mastery learning, individual tutors, small and large group instruction and/or cooperative teams. They emphasized alternatives and choices, adapting to the students' particular needs. Two characteristics common to both mastery learning and adaptive education included periodic mastery reports and provisions for alternatives or corrective learning.

Walberg, Herbert J. "Improving the Productivity of America's Schools." Educational Leadership. May, 1984, 41:19-27.

Wahlberg's synthesis of nearly 3,000 investigations found nine factors inherent in educational productivity. The factors were subdivided into the following categories: Student Aptitude- 1) Ability or prior achievement, 2) Development or maturation, 3) Motivation; Instruction- 4) Learning time, 5) Instructional quality; and Environment- 6) Home, 7) Classroom social group, 8) Peer group outside the classroom and 9) Use of out-of-school time. Wahlberg noted that the first five aspects of student aptitude and instruction are found in Carroll and Bloom's mastery learning models. Upon investigating various methods of instruction he also found that components of mastery learning ranked first and fourth in their positive effects on educational outcomes. Reward or Skinnerian reinforcement had the largest overall average effect. Accelerated programs ranked second. Wahlberg's stated purpose of his research was to provide a knowledge base for educational practices rather than the usual dependence on educational fads.

IMPLEMENTATION OF MASTERY LEARNING

Alexander, William M. and Paul S. George. The Exemplary Middle School. New York: Holt, Rinehart and Winston, 1981.

Alexander and George proposed that mastery learning denies the inevitability of the normal curve in academic achievement. The process of implementing mastery learning was outlined as follows: 1) Set the program standards. Analyze the curriculum and divide it into small units of learning objectives. 2) Select the pattern of instruction and design approximately five learning activities per objective. 3) Set the mastery standards and develop formative tests. 4) Prescribe correctives, from the activities designed above, for students who did not attain mastery of the formative tests. 5) Develop and administer summative tests. The authors contented that the time frame must be altered so that individual students will be able to attain mastery.

Anderson, Lorin W. "An Empirical Investigation of Individual Differences in Time to Learn." Journal of Educational Psychology. 1976, 68:226-233.

The purpose of this study was to examine the variable of time in individual achievement levels as well as the stability of time to achieve over subsequent units. Results of previous studies were cited which showed achievement time of slow to fast students ranging from one to seven. Anderson's subjects were eighty-two midwestern, middle-class, eighth graders. The students studied a three unit arithmetic matrix program. There were three major variables in the study: elapsed time (clock time between starting and completion); time-on-task (active involvement); and achievement. Time-on-task was measured by students as well as an observer. Correlation and data tables revealed two major conclusions. Mastery learning effects time-on-task to achieve. Unequal amounts of time on task helps a greater number of students to learn. Anderson's second conclusion added a new dimension to mastery learning. After a number of units, students approach equality in the amount of time-on-task to achieve.

Arlin, Marshall and Janet Webster. "Time Costs of Mastery Learning." Journal of Education Psychology. 1983, 75:187-195.

Participants of this experiment were 122 seventh grade students from two middle-class suburban schools near Vancouver, Canada. Materials for the unit were developed from a juvenile book on sailing. In this unorthodox procedure both mastery and nonmastery students were mixed in each of the four classrooms. there was no group teaching, but rather, books were distributed face-down and were read on signal. Upon finishing, students took a quiz. Fast finishers were allowed to do other homework and only mastery students received feedback. Achievement was assessed as the number right on the four final chapter quizes. The mastery group learned faster and at higher levels and also retained more. Arlin and Webster also discovered that the time needed for mastery, doubled that of the nonmastery group. Also the mastery time of slow and and fast students remained constant for all four chapters. "Admittedly the study was short," stated Arlin and Webster though they concluded from it that the price of achievement of mastery learning costs extra remedial time and what they labeled as "wasted time" for fast learners.

Arlin, Marshall. "Teacher Responses to Student Time Differences in Mastery Learning." American Journal of Education. August, 1982, 90:334-352.

The essence of Arlin's article was time. Arlin presented a model for analyzing a teacher's juggling of time in the classroom as a relationship of aptitude, depth or breadth of coverage and student cooperation. He superimposed this time model into a mastery learning situation and contended that teachers would have problems obtaining extra time to bring slower students to mastery levels. An analysis of 10 elementary school teachers who each taught short, 10 day mastery units, further supported his assumption. All teachers were 10 year veterans but had recently been exposed to mastery learning and had been given 6 weeks to write their mastery units. None of them were able to resolve the dilemma of time in their mastery learning units. Most compensated with shorter lesson plans to make time for retesting and remedial instruction. Extra time was also found during recess, lunch and after school. Enrichment became free time or "high-powered busywork." Arlin did not debate the fact that the mastery students had higher achievement than nonmastery but questioned the feasibility of time to reach mastery for all students.

Arlin, Marshall. "Time Variability in Mastery Learning." American Educational Research Journal. Spring, 1984, 21:103-120.

Arlin presented empirical evidence to refute the claim of mastery learning theorists that with prolonged mastery strategies the time variable between slow and fast students will be reduced. Arlin's evidence came from two classroom experiments. The first was a 10 day unit taught in four separate schools in a semi-rural British Columbia setting. A slight decrease in time needs evolved until the final review lesson which altered the downward trend. The second study extended from first through fourth grade in arithmetic. The mastery group consisted of 56 students from a district on the northeast coast of the United Stated. Data was computed against three variables. They were 1) the ratio of the slowest to the fastest 25 percent of students per unit, 2) the ratio of standard deviation to the mean scores, and 3) the intercorrelations of the total time spent to master the selected units for each of the four grades. Arlin admitted that he did not have control over the collection of data and time measured was only an approximation of true time to mastery. However, he maintained that the need of the slower students for extra time does not diminish, but in fact remains constant. The trend analysis, as verified by tables, suggested that students who needed more time for mastery in first grade still needed more time in later grades.

Block, James H. Schools, Society, and Mastery Learning. New York: Holt, Rinehart and Winston, Inc., 1974.

Block examined two aspects of mastery learning, successful implementation and the social and economic implications of its use. The author recapitulated the history and theory behind mastery learning (ML) and compared it to Keller's Personalized System of Instruction (PSI). The following major differences were noted: Bloom's ML uses group not individual-based instruction, units are teacher, not student-paced, units are larger, and grades are based on summative tests. Keller's PSI grades are figured on the number of units completed over a specific time. Research was presented that addressed such "hot" issues as time "trade-off" and learning rates. Bloom hypothesized: "under appropriate instructional conditions, there are really very small individual differences in rates of learning - slow and fast learners are created." (p. 61) Study results indicated that learning ratios of fast and slow learners, with appropriate instruction, decreased over time.

Carroll, John B. "Problems of Measurement Related to the Concept of Learning for Mastery." Educational Horizons. 1970, 48:71-80.

Carroll explained his "model of school learning" (1963) and dealt with the resultant difficulty of measuring the concept of mastery learning. According to Carroll, the various components of the learning process have not been measured accurately because they interact and are functions of each other. Difficulties encountered have been in the areas of measuring rate and time of learning as well as quality of instruction. Achievement has been best measured with criterion-referenced tests, but their development is problematic in that learning is complex and cannot always be broken down into specific goals. Measurement assumptions that have been made, need more research and testing. The author concluded that when the components of learning can be measured then learning can be "managed" to produce mastery.

Fitzpatrick, Kathleen A. A Group-Based Mastery Learning: A Robin Hood Approach to Instruction? Educational Resources Information Center, ED 255 556, March, 1985, 25 pp.

This study investigated the issue of allocating class time for a distinguishing feature of mastery learning, its feedback-corrective/enrichment loop. The results of this paper indicated that Arlin's Robin Hood description of mastery learning, robbing time from the talented to give to the academically poor, is ironical. (Arlin 1982) Fitzpatrick's staff development activities were more extensive and based on effective teaching research. High school mathematics teachers in both mastery treatment and traditional control classes were observed in pre- and post-teaching conditions. The feedback-corrective/enrichment loop went from an almost nonexistant state before training to 20 percent of class time. Analysis tables showed a shift in class time from independent practice to more student-teacher interaction. The author concluded that carefully planned staff development is necessary for an effective implementation of mastery learning. Contrary to Arlin's claims, Fitzpatrick reported, "The rich get richer."

Guskey, Thomas R. Implementing Mastery Learning. Belmont: Wadsworth Publishing Company, 1985.

Guskey's book was written as a guide for teachers to implement mastery learning. Results of studies were included to support the basic philosophy that mastery learning improves achievement - with appropriate instruction nearly all students can learn successfully. Only chapter one dealt with the history and development of mastery learning, including Carroll's, Bloom's, and Keller's models. The rest of the book addressed practical classroom management and implementation techniques. Each phase of the mastery sequence was explicated - learning objectives, formative and summative examinations, correctives, enrichment activities and program evaluation. Sample lesson plans for specific subjects and grade levels were included as well as letters to parents explaining the teaching strategies.

Hales, Carma M., Director and Donald J. Parr, Chairman. Teaching for Mastery in Mathematics, Educational Resources Information Center, ED 171 513, Utah System Approach to Individualized Learning Consortium, Salt Lake City, Utah, 1976, 26 pp.

The Utah System Approach to Individualized Learning (U-SAIL), a multi-district, state-wide consortium developed an individualized system for instruction in mathematics. The document presented specific guidelines for teaching mathematics in an individualized program. Planning, organizational, management and instructional cues, based on mastery learning philosophies, were given in outline format. Basic math skills were shown as a hierarchy of units of work (called pacs), organized into a sequence for instruction. Also included were sample management charts and a thorough record keeping system for both students and teachers.

Hart, Leslie A. "Brain-Based Learning Theory Can Clear the Way for Mastery." Outcomes. Fall, 1985:28-32.

Hart viewed "mastery" in education as a radical change! "Bloom's claim that all students can learn was an anti-thesis of ranking, screening, labeling (as a scape-goat) and producing one-third failure," stated Hart. The author presented the following obstacles of school reform: 1) Teachers are independent entities and lack common beliefs; and 2) School systems are not susceptible to broad changes without mandated legislation. The Proster Theory for training teachers in mastery was proposed. An impressive Proster-Mastery application at Perry L. Drew, K-5, in New Jersey was cited. Hart concluded that schools should begin with theory, move to program design and then mastery/zero failure implementation.

Klein, Jerry W. "Designing a Mastery Learning Program." Educational Leadership. November, 1979:144-147.

Klein suggested that a school staff, interested in implementing mastery learning, needs to develop their own model. He outlined a possible four-step process. The steps were as follows: 1) Derive program standards - Analyze mastery learning concepts by Block, Bloom and Carroll. Discuss and develop program characteristics. 2) Select the pattern of instruction - Options to consider are who sets the objectives and instructional activities. 3) Select the form of instruction. Decide who and how instructions will be delivered and the types of grouping and and activities. 4) Derive the instructional program. Develop a model with operational details. Klein dealt primarily with the design phase of mastery learning and referred the reader to others for writing actual objectives, instructional material, tests and record keeping.

Knight, Tanis. "Mastery Learning: A Report From the Firing Line." Educational Leadership. November, 1981:134-146.

Knight was the coordinator of Project WRITE in Vancouver, Washington. Two school districts in his area addressed the problem of attaining high writing skill levels in the middle school grades, 6, 7 and 8. Having been convinced of the promising results of Bloom's research, project managers and teachers were given the task of implementing Mastery Learning in the classroom to ensure high writing standards. The components of Project WRITE were to develop a skill sequence, develop at least three to four corrective activities per skill, intensive extension or enrichment activities, alternate tests and a preservice plan to train teachers on how to use the materials. Knight determined that effective mastery learning requires a director or coordinator and plenty of time for developing materials and activities before classroom instruction. Knight ended with, "Mastery Learning can work and the implications are very exciting, BUT IT ISN'T EASY!"

Taylor, Gary L. "Mastery Learning: A Prescriptive for Success." NASSP Bulletin. September, 1983:84-89.

Taylor stated that a major contribution to the success of mastery learning at Reed Junior Hih in Loveland, Colorado, was a comprehensive inservice training to teach and practice skills as well as clinical observations of the teacher-learning process. Mastery feedback forms were included that had been adapted from the works of Bloom, Hunter and Gagne. Inherent to Reed's program in language arts and mathematics was the philosophy that ALL students can learn! The following learning conditions were met: Criterion-references objectives - students are clearly aware of expectations; Systematic instruction with three week modules designed for sequencing; Student remediation and enrichment; positive reinforcement. Further all curriculum was designed to be consistent with the mastery learning philosophy - Diagnosis, Prescription, Orientation, Feedback and Evaluation. According to Taylor, mastery learning had provided the tool for significant improvement in the quality of the teacher-learning situation. No comparative raw scores or data were given to support this claim.

STUDIES OF MASTERY LEARNING IN MATHEMATICS

Abrams, Joan D. "Making Outcome-Based Education Work." Educational Leadership. September, 1985, 43:30-32.

Eight years ago, Abrams, the Superintendent of Red Bank, New Jersey, a borough of 60 percent minority population, convinced the Board of Education to use Outcome Based Education. Bloom's test-retest cycle and a modification of Hunter's model were utilized. A premise was that teachers were accountable for teaching grade level instruction to all children. Formative tests separated mastery from non-mastery and resulted in correctives or extensions. Mastery tests established the final grade. Abram's mandate to raise achievement scores was fulfilled. Red Bank, at the time of publication, was "well above" the national norms. The article stated that a strong continuing inservice was a factor. How the objectives, supplementary materials, formative tests, additional and enrichment activities were developed was not discussed, except to say that Red Bank had to formulate their own materials as no textbooks satisfied their needs for outcome based education.

Burrows, Charles K. and James R. Okey. The Effects of a Mastery Learning Strategy on Achievement. Educational Resources Information Center, ED 109 240, April, 1975, 13 pp.

The subjects of this study were eighty-four fourth and fifth graders. Students were divided into two skill levels, below and above the fiftieth percentile. Rankings were based on the Arithmetic Skills Test of the Iowa Test of Basic Skills. The regular classroom teachers and aids taught a geometry unit of 14 separate skills. Commercially published materials were used. Following a prerequisite unit, students were randomly divided into one of four groups. The groups ranged from conventional instruction to mastery learning. Groups two and three contained only fragments of mastery learning, defining objectives, formative tests or correctives. The full mastery group scored significantly higher than all others. Even students of low math aptitude in the mastery group outperformed students of high math aptitude in the control class. There was no difference in achievement between the fourth and fifth grade students.

Conner, Katherine, Jerald Hairston, Inez Hill, Henry Kopple, John Marshall, Karen Scholnick, and Marcia Schulman. "Using Formative Testing at the Classroom, School, and District Levels." Educational Leadership. October, 1985:63-67.

Fifteen elementary schools in the Philadelphia Mastery Learning Program have set school wide goals and have used Mastery Mathematics. The Mathematics Office has devised the formative tests and results are periodically analyzed by principals. At another step up the ladder the District itself employs criterion-referenced tests. Reading and writing have been included in the program which has raised achievement levels. At all levels four features have been found to be essential: 1) The belief that all students can learn; 2) Formative tests measure specific content goals; 3) Data is collected periodically while there is time for correction; 4) Problems are diagnosed and correctives employed. Conner and her co-authors state, "In all cases, the emphasis is on diagnosis, problem solving, and support - not on making excuses for failures or on blaming."

Dolan, Lawrence. "Affective Characteristics of the Adult Learner: A Study of Mastery Based Instruction." Community/Junior College Quarterly. 1983, 7:367-378.

The focus of this study was to investigate the effectiveness of mastery learning for "high risk" adult learners, returning to formal education. Pre- and post-tests of students assigned to basic math were compared in areas of self-concept, interest, and achievement of skills. Students were randomly assigned to four classes of Developmental Mathematics at a community college in New York. The average age was 29, being out of school at least 5 years, 60 percent were male and 71 percent were white. The classes were in the evening as 83 percent of the sample were employed full-time. Students were career orientated but lacked basic skills. Two teachers developed the mastery learning material at a summer workshop. The same teachers taught both mastery and non-mastery classes, using the same lectures. The non-mastery classes did not have formative tests or correctives. Mastery classes were significantly higher in all areas. The patterns indicated that mastery minimized individual differences and was effective for both high and low ability students.

Doyle, James R. "Outcome-Based Education Application." Outcomes. Summer, 1986:42-46.

The West Bloomfield School District, in the metropolitan, Detroit, Michigan, area, in three years increased their ranking in basic math skills from twenty-seventh to third out of eighty-two districts in a tri-county area. Three of their seven buildings have been designated as exemplary schools in Michigan and an elementary and one middle school have received national recognition. Assistant Superintendent, Doyle, accredits the success to the implementation of an outcome-based program of mastery learning as well as a strong commitment by teachers and educators to refuse to allow children to fail! In West Bloomfield the first area taught with mastery learning was math but the teaching strategy spread to reading, writing and social studies, through all grade levels. An invitation was extended to share their computerized program and criterion-referenced tests.

Fehlen, Joan E. "Mastery Learning Techniques in the Traditional Classroom Setting." School Science and Mathematics. 1976, 3:241:245.

One-hundred-twenty-seven perspective elementary teachers enrolled as sophomores in two Minnesota college math classes were the sample of this experiment in Mastery Learning. Results indicated that the sample group had higher mean achievement and attitude scores than those taught in the traditional classroom setting. The study suggested that the crucial factor was that students had the opportunity to retake tests. Background information on Mastery Learning was included. Fehlen quotes Bloom as saying that given enough time at least 90 percent of all students are capable of mastering the given objectives of a course. The bell curve, according to Bloom is the most wasteful and destructive aspect of the present educational system. The results of research studies by Collins, Mayo and others were also included to bolster the case for mastery learning. In all studies, the effect of retesting and tutorial help consistently produced higher mean attitude and achievement scores than the traditional lecture-question-answer method. Fehlen concludes that mastery techniques are effective in any traditional classroom.

Gonis, Antonios. "Arithmetic Through Mastery Learning." Journal of Developmental & Remedial Instruction. Winter, 1979, 3:12-13.

Gonis presents a brief history of Mastery Learning (ML) and the Personalized System of Instruction (PSI). He describes PSI as one of the best and most widely known instructional methods of MS. Gonis lists characteristics of PSI application as well as problems associated with its use. He alludes to the fact that though successful, it might be better if modified. Such an experiment was conducted at LaGuardia College using common features of PSI but also departing from it in many respects. Adult students in arithmetic were divided into Experimental ML and Traditional classes. The tests and course were described but the sample was not clearly identified. The deviations from PSI as reported by Gonis include systematic objectives, assignment sheets, correctives, tutors available during student "free" time, mastery completion of 10 of 11 units guaranteeing an "A," regular, mandatory classes and lectures used as the primary delivery system. The Laguardia staff found it more cost effective than PSI and the skill progress of students more impressive. Comparative graphs were included in the study report.

Grossman, Anne S. "Mastery Learning and Peer Tutoring in a Special Program." Mathematics Teacher. January, 1985, 78:24-27.

Five New York high schools and the University of New York formed an educational consortium called College Discovery and Development Program (CDDP). Three of the five high schools were Title I. All had a large percentage of students whose test records indicated they were well below grade level. Various teaching strategies, through CDDP, were explored to improve success in a first-year algebra course. A success story evolved, according to Grossman, because of a teacher selected for this experiment, Herbert Stender and his implementation of mastery-learning techniques in the classroom. After one school year, the marginal math students, many of whom had previously been enrolled in remedial math, had a higher rate of success on the New York State Regents Examination than the students of the rest of the school! Peer tutoring and a double class time period were also utilized. As a bonus, attitude and attendance improved as well.

Haver, William. "Developing Skills in College Algebra - A Mastery Approach." Two-Year College Math Journal. November, 1987:282-287.

Reported successes of Personalized System of Instruction (PSI) prompted the math department at the University of Tennessee, Knoxville, to develop a Mastery Learning Format. The study encompassed Math 1540 students, Liberal Arts, Business and Agriculture majors. The goals as stated by Professor Haver were as follows: 1) All students will have mastered the basic material with a grade of 90 percent or better; 2) A larger percentage of students will successfully complete the course than in the past; 3) Students' attitudes toward math would improve. At the time of the publication, 1,300 students had taken Math 1540 under the new teaching method. Data charts were provided with comparative effectiveness information. Each of the six quarters showed a larger percentage of student successful completion than the previous quarter and all were above the departmental average. All goals were met. Haver concluded that students succeeded because of the mastery learning approach of knowing what to expect and having help available.

Larkin, Jill H., and George Brackett. "Mathematics Prerequisites: A Mastery Approach." American Journal of Physics. December, 1974, 42;12:1089-1091.

A prerequisite mathematics mastery learning unit was developed by Professor Reif at the University of California, Berkley. The review unit covering pre-college level skills, arithmetic, scientific notation, algebra and trigonometry, was necessary since half of the students entering Physics 6 were lacking in basic math skills. Physics 6, a one year course, was designed for students interested in biology and medicine. Repeatable tests, to establish mastery levels was adopted from the Keller or Personalized System of Instruction (PSI). The unit proved manageable with classes as large as 350 students. There was little teaching or instructor input as the review packets were self-explanatory. Larkin attributed the success of student mastery to the fact that students were sufficiently goal orientated and they had a realistic assessment of their abilities through repeated testing. Tests were short, half hour with 15 questions and straightforward with no tricks. Among 550 students in three classes using the math-review unit, every student who repeated the test after failing it once, eventually passed with mastery.

Mavarech, Zemira. "The Effects of Cooperative Mastery Learning Strategies on Mathematics Achievement." Journal of Educational Research. August, 1985, 78:372-376.

The subjects of this study were one-hundred-thirty-four fifth grade math students in Israel. The children were predominantly from middle class families. Mavarech, of Bar-Ilan University, studied the effects of using three different instructional techniques on student teams. The techniques were Student Team Learning (STL), Mastery Learning Strategy (MSL) and a combination Student-Team Mastery Learning (STML). STL was most effective with lower level skills and STML also had a positive effect on math development. Classes, however, exposed solely to MLS significantly outscored all other instructional techniques. Both computational skills as well as comprehension, word problems, increased with MLS. Previous studies with low income students were not consistent, according to Mavarech, because of their inability to cooperate and work as team members. Mavarech also warned that since the samples were limited, generalities should also be limited.

Provine, Doug. "A Strategy for Mastery Learning." Math and Computer Education. Spring, 1985, 19:112-114.

Provine reported on his first experience with mastery learning. After attending a Mastery Learning Conference in Chicago in 1982, Provine restructured his beginning Algebra I course at Sinclair Community College to incorporate mastery learning. The five major components of mastery learning were adapted by Provine in the following manner: 1) Learning Objectives - He did not formulate a list but referred to the problems at the end of each section as objectives. 2) Instruction - The same activities and techniques were used as in the past. 3) Formative Tests - Mastery quizes were given after several class periods. They were 10 to 20 minutes in length and graded immediately. Mastery was set at 85 percent. 4) Correctives - Students worked on their own time with videos, tapes, handouts and worksheets. 5) Summative Tests - The same tests were used as in previous years with traditional classes. In the first year of mastery learning, raw scores on chapter tests increased from 12 to 22 percent per chapter. Provine outlined plans for future improvements, including the development of a mastery learning center for proctoring tests, correctives and individual work areas.

Rollins, Sidney P. "The Coventry, Rhode Island Mastery Learning Project." Education. Winter, 1983, 104:120-127.

Rollins reported on a Mastery Learning Project with seventh and eighth grade students at Coventry Junior High in Rhode Island. Subjects included in the study were English, Science, Mathematics and Geography. Data was acquired from pre- and post-tests measuring percent of increase or improvement of learning. Data was insignificant for English as there was a change in staff. Geography was divided into a skills and content area. All areas, except Geography skills, showed greater achievement in mastery learning classes than those taught in a conventional manner. Geography skills improvement was relatively the same with both strategies. Students in mastery taught classes were very supportive. Better students liked the opportunities for acceleration and slower students reported feeling "hope!" Teachers were also happy with the improvement shown with mastery taught classes but thought it wasn't quite as dramatic as other studies might suggest. They agreed that the second year would be easier as the previous summer had been spent in developing curriculum.

Rubin, Stephen E. and William G. Spady. "Achieving Excellence Through Outcome-Based Instructional Delivery." Educational Leadership. May, 1984:37-44.

Rubin and Spady report on the success of the academic achievement of students at Center School in New Canaan, Connecticut. Center School has a heterogeneous, K-6, middle-class population of 400 students and 16 teachers. The outcome-based instructional model has been in effect with continual refinement, for the past 15 years. A key element of the program was that the curriculum was broken into a hierarchy of objectives. Students were tested and grouped according to skills needed. Time on task and abilities were variables as students progressed independently from skill to skill. Subjects, as math, reading and writing, were block scheduled one hour each day. The entire staff shared in the teaching of each subject in various flexible ability levels. Student placement, testing and all records were handled by the Instructional Resource Center (IRC) on computer disks. The IRC was also the locale of potential teaching materials since the program prescribed to no particular test or teaching technique! The mathematics program, with 231 skill objectives, K-6, boosted phenomenal results. Two such results were 1) No more than one or two students per year in the entire school fail to reach grade level on standardized mathematics tests (including mildly handicapped students)! 2) Between 10 and 20 percent of the 6th graders each year complete the first half of Algebra I!

Slavin, Robert E. and Nancy L. Karweit. "Mastery Learning and Student Teams: A Factorial Experiment in Urban General Mathematics Classes." American Educational Research Journal. Winter, 1984, 21:725-736.

This study conducted by Slavin and Karweit investigated elements of Carroll's Model of School Learning. The study attempted to compare the effectiveness of mastery learning, team learning, a combination mastery-team and conventional instruction. Ninth grade general mathematics classes from inner city Philadelphia served as the base for instruction. The average achievement level of the students, at pre-test, was 4.3 grade equivalent. The students were 83 percent minority. After the year-long experiment, results indicated that team work, with team rewards, was the most effective strategy in raising achievement levels. The combination group of team and mastery came in a close second with mastery learning by itself, only slightly better than the conventional instruction in raising achievement levels. Slavin suggested several possibilities for the outcome of the group-paced mastery classes - the instructional strategy was poorly suited to population needs and pacing may not have been heeded as the mastery and non-mastery groups proceeded at the same rate. Slavin discounted the traditional mastery learning success stories on the basis of a "critical flaw," namely time for correctives or remediation in a structured setting.

Thompson, Samuel B. "Do Individualized Mastery and Traditional Instructional Systems Yield Different Course Effects in College Calculus?" American Educational Research Journal. Fall, 1980, 17:361-375.

A comparison study of Keller's Personalized System of Instruction (PSI) and the conventional lecture-discussion-recitation (LDR) strategies was conducted with 840 college calculus freshmen at the United States Air Force Academy in Colorado. The study spanned two years and was well documented. The experiment groups and instructors were well-balanced, and virtually equal in strength. In contrast to other PSI success tories, there was relatively no difference between the two instructional groups in either achievement or attitude. Thompson suggests that perhaps some of the other reports may have been attributed to inferior LDR instruction and not necessarily superior PSI strategies!

Wagner, John and Howard Jones. "Group-Based Instruction: The Best Chance for Success?" Two Year College Math Journal. 1973, 4:51-554.

A Mathematics Study Group at Michigan State University, set up an experiment of seventh grade math students. One group between the 25th and 50th percentile studied a course for two years. Another group between the 50th and 75th percentile studied the same course for one year. There was virtually no difference in tests scores, administered after each group finished the course. Wagner and Jones contended that rigid time schedules have adverse effects on many math students. A similar study at Michigan State University for a non-credit, remedial algebra course had the same results. When correctives were added for the low students, the passing percents jumped from 51 to 74. Based on approximately 40 major studies, Bloom found that mastery learning enabled 75 to 90 percent of students to achieve at the same level as the "normal" curve, top 25 percent.

SUMMARY

The idea that students may not have been successful in school because they needed more time to learn was first introduced by Carroll in 1963. His Model of School Learning defined the degree of learning as a function of time actually spent on a task in relation to the time needed to achieve (Carroll 1963). Carroll's model called for learning to be broken into specific measurable units. Time spent and time needed were further severed into five variables: aptitude; ability to understand instruction; quality of instruction; time spent in learning and perseverance (Carroll 1963). Bloom was greatly impressed with Carroll's model and along with Block and Anderson researched it extensively. Bloom developed a teaching strategy called mastery learning that was comprised of three independent variables: Cognitive entry behaviors - history of previous learning; Affective entry characteristics - extent the student can be motivated and Quality of Instruction (Bloom 1976). Bloom proposed that 95 percent of the students could learn a subject to a high level of mastery and that "under favorable learning conditions" students become similar with respect to learning rates and motivation (Bloom 1968). He further attacked the present educational system and its expectations, labelling it, "a pernicious self-fulfilling prophecy." (Bloom 1968) Bloom developed the feedback/corrective, enrichment loop as part of his teaching strategy.

Keller developed an individualized mastery approach known as the Personalized System of Instruction or PSI. Based on an underlying theme of reinforcement learning, Keller described his approach as an extension of programmed instruction with human, proctor, feedback (Keller 1968). Hyman and Cohen (1979), having researched 3,000 schools, found PSI to be more effective than mastery learning. The main differences of mastery learning and PSI were outlined by Block. Block stated that PSI was student- rather than teacher-paced, grades were assigned according to the number of units successfully completed within a specific time frame and instruction was also individual rather than group based as in mastery learning (Block 1974).

Why mastery learning over traditional instruction? In comparing mastery to non-mastery groups, numerous studies have shown that mastery learning has a positive effect on academic achievement, student attitudes and motivation. After researching thirty-three references, mastery learning was found to be an effective motivator of students to learn in that it maintained success expectations (Brophy 1987). Okey (1977) found that in a study of 20 classrooms in Indianapolis, mastery groups exhibited more favorable attitudes toward school and learning as well as higher achievement. In a variety of other studies the results have been the same. Chandler (1982) synthesized 150 studies and found the majority to be in favor of mastery learning. One common element in the outstanding achievement gains of 19 elementary schools in Michigan was a mastery learning instruction program (Clancey 1982).

Other successful stories of academic achievement with mastery learning strategies came from the marines in California (Evans 1981) and the entire state of Utah's rural schools (Nelson 1985).

The process of implementing a mastery program was established by Alexander and George (1981) as follows: 1) Set the program standards by analyzing the curriculum and dividing it into small units of learning objectives; 2) Select the pattern of instruction by designing five learning activities per objective; 3) Set the mastery standards and develop formative tests; 4) Prescribe correctives and enrichment and 5) Develop and administer summative tests. Another similar version which dealt with the design phase and construction of a model was suggested by Klein (1979). Perhaps the classroom teacher's Bible for implementing mastery learning, with a chapter devoted to the development of each phase, objectives, formative tests, summative tests, corrective activities, enrichment activities, program evaluation as well as sample lessons was written by Guskey (1985).

Arlin (1982, 1983, 1984) debated the feasibility of working corrective and enrichment activities within the normal classroom time frame. In his studies teachers used extra time, recess and after school for remediation and retesting while enrichment activities became free time or "high powered busywork." Arlin (1984) also presented evidence to refute the claim that the time variable between fast and slow students would diminish after prolonged mastery strategies (Block 1974). It should be noted

that Arlin's study was only a ten-day unit. Anderson (1976) found that students approached equality of time-on-task to achieve over a prolonged period of time and with "optimum learning conditions." Fitzpatrick (1985) directly attacked Arlin's Robin Hood theory of robbing from the talented to give to the poor student. Fitzpatrick concluded that a successful mastery learning program requires a carefully planned staff development. Taylor concurred with Fitzpatrick's finding that a comprehensive inservice is imperative for a successful mastery learning situation (Taylor 1983). Taylor, a principal of a junior high in Colorado, spoke from experience, as his school's program was outlined and boasted of improved quality of education.

After coordinating a two district Project Write in Washington, Knight (1981) advised allowing time for material and activity development before instruction begins. Knight concluded, "Mastery learning can work and the implications are very exciting, but it isn't easy!"

The majority of mastery learning field test studies have dealt with mathematics or reading. Being sequential by nature, mathematics has well-defined learning objectives which can be broken down into smaller, measurable learning tasks, making it readily adaptable to mastery strategies. Results have been expressed as positive, successful, impressive and phenomenal. Positive results have come from high-risk adults returning to school (Dolan 1983), Minnesota college students seeking teaching degrees (Fehlen 1976) as well as seventh and eighth grade math

students in Rhode Island (Rollins 1983). Impressive gains in academic achievement with mastery learning were reported at the West Bloomfield School District in Michigan (Doyle 1986) at Sinclair Community College for Algebra I students (Provine 1985) as well as Red Bank, New Jersey, which with 60 percent minority, raised its achievement scores well above the national norm. (Abrams 1985) Burrows and Okey studied the effects of mastery learning in relation to low and high skill level students as well as spanning two grade levels. With fourth and fifth grade students they found that mastery level low ability out-performed, non-mastery high-ability students when taught an isolated geometry unit. Grade levels made no difference (Burrows, Okey 1975). District employed criterion referenced tests in a Mastery Mathematics Program in Philadelphia helped bring about successful achievement levels (Conner, Hairston, Hill, Kopple, Marshal, Scholnick, Schulman 1985).

Studies of mastery learning in mathematics run the gamut from kindergarten through at-risk adults and are international in scope. Wagner and Jones having analyzed the results of two Michigan based studies of seventh graders and non-credit mathematics college students summarized that, "It's high-time to use flexible time scheduling and mastery learning to increase success in mathematics (Wagner, Jones 1973).

CONCLUSIONS

Traditional group instruction has proven to be destructive and counter-productive for too many of our young people. since its inception, the conventional bell curve has guaranteed only one-third mastery while the rest of the students just get by, or worse, fail. The "C" group of nonmastery have become the norm or average. At early ages, egoes have been destroyed, and self-concepts, increasingly damaged. The loss of human potential is not only psychological but financial as well. In an increasingly technological society, we can no longer afford to produce failure. A change has to be made in our present educational system.

Mastery learning has provided hope. How innovative and refreshing it would be for our educational system to support a teaching strategy that expected mastery for all, or at least for the majority! The implementation of a mastery program has forced schools to scrutinize their curriculums and clearly define their learning objectives. Not only are these goals or objectives stated, they are taught and tested. Common sense would dictate this as the rule and not the exception, but with traditional educational experiences, many a man-hour has been wasted writing broad subject objectives and guidelines, producing volumes of K-12 literature, only to be lost at the bottom of a teacher's desk!

The results of academic achievement in mathematics field testing have been too good to be ignored. For the past two

decades numerous studies have shown that mastery groups out-performed traditional or non-mastery groups. Mastery learning has also proven to have positive effects on self-worth and attitudes toward school and learning in general. Many studies also claimed that retention was enhanced by mastery strategies. On the other side of the coin, the literature brought out some "hot contended areas" concerning problems with classroom time frames, enrichment activities and teacher training. As Guskey (1985) pointed out, "Mastery learning is not a panacea for all our ills, but research has indicated a strong improvement in academic outcomes, and as such, is worth the effort." More research and field testing are needed to iron out the wrinkles.

It is frustrating to grade a test with "too many" failures. The majority of our students are not at mastery with traditional teaching strategies and as such the talents and energies of many good, dedicated educators have been misguided. Education was meant to be the key to success, but we are not opening all the doors. Let's try a new key!

RECOMMENDATIONS

Based on this study, the following is recommended:

1. Raise teacher expectations by exposing educators, through extensive in-service, conferences or workshops to the philosophies of Carroll and Bloom - namely that all students can learn and most can achieve mastery.
2. As a result of increased awareness and education, school districts or corporations work to design programs, set educational standards and develop a model of operational details.
3. Districts or corporations provide release time or in-service for departmental program implementation - writing learning objectives and parallel corrective and enrichment activities as well as designing formative and summative tests.
4. Outcome based national networks develop and operate computer resource banks for sharing corrective and enrichment activities, tied to specific learning objectives.
5. Publishers produce curriculum materials suitable to mastery learning, with formative and summative tests as well as corrective and enrichment activities linked to specific learning objectives.

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BACKGROUND

I. Name: Lois L. DeVaux

II. Address: 1305 Indiana Avenue
LaPorte, IN 46350

III. Educational Background:

School	Year of Graduation	Degree
Summit #1 Great Bend, ND	1961	
Wahpeton High School Wahpeton, ND	1965	H.S. Diploma
Purdue University	1982	B.A. Elementary Education
Indiana University South Bend, IN	1986	Middle School Math Endorsement

IV. Employment Experience:

LaPorte School Corporation LaPorte, IN	1984-present	Teacher 8th Grade Math

V. Qualifications for this Study:

I have taught eighth grade for four years and have an Elementary Education License and a Middle School Endorsement in mathematics. Upon completion of this Exit Project I will have a Masters Degree in Secondary Mathematics.

I was introduced to the principle of mastery learning in graduate courses. I am presently on an Outcome Based Education Research Committee at Kesling Middle School in LaPorte, sponsored by a grant from the Eli Lilly Foundation. As such, I have had the opportunity to visit Decator Middle School in Indiana, which has implemented mastery learning in mathematics and also attended a Northwest Indiana Educators Conference on Outcome Based Education.

VI. Personal Interest in the Topic:

I am sold on the idea of mastery learning! We can no longer afford to successfully educate only a few. I intend to rewrite and implement a mathematics curriculum based on the principles of mastery learning.

As a professional educator, I am interested in keeping abreast of developments in educational research and effective teaching techniques. Beyond the ramifications of teacher accountability, I am concerned about improving the academic achievement of my students, their attitude toward mathematics and their feelings of self worth.